Laser Ion Source Development for ISOL Systems at RIA

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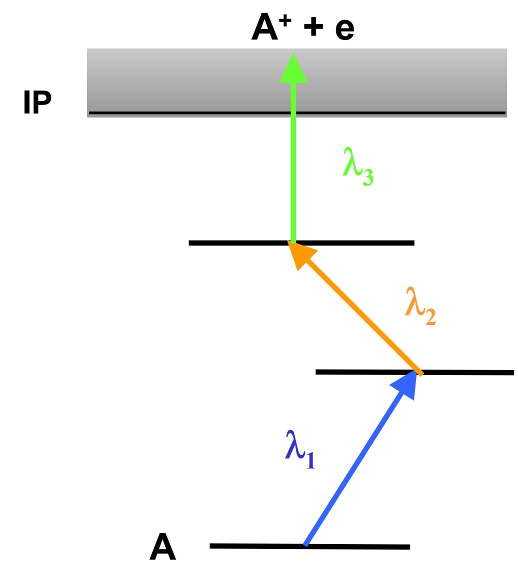
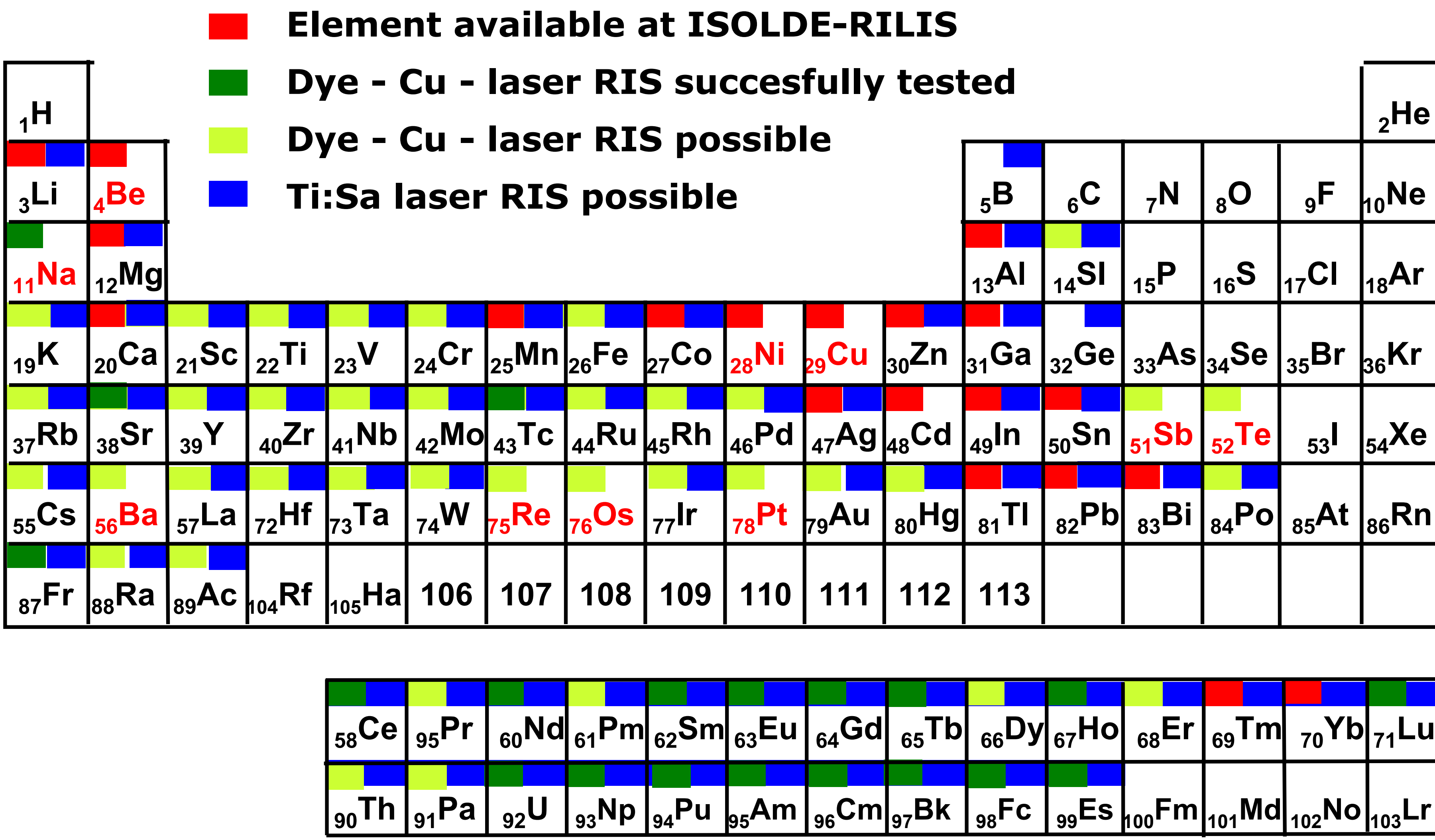
Laser Ion Source Based On Resonant Photoionization

Ions of a selected element are produced via stepwise resonant photo excitations followed by ionization in the last transition.



- highly selective
- efficient
- versatile -- applicable to about 80% of all the elements in the periodic table (ionization potential <10eV)

Develop New Ionization Schemes



Bruce A. Marsh, “Thermoionization in Hot Cavity Laser Ion Sources,” TARGISOL 2002 Winter School

Laser ion sources are being used or developed for on-line production of RIBs at several ISOL facilities

ISOLDE (CERN)

ISAC/TRIUMF

GSI

Institute of Spectroscopy (Troitsk)

IRIS (Gatchina)

Mainz University

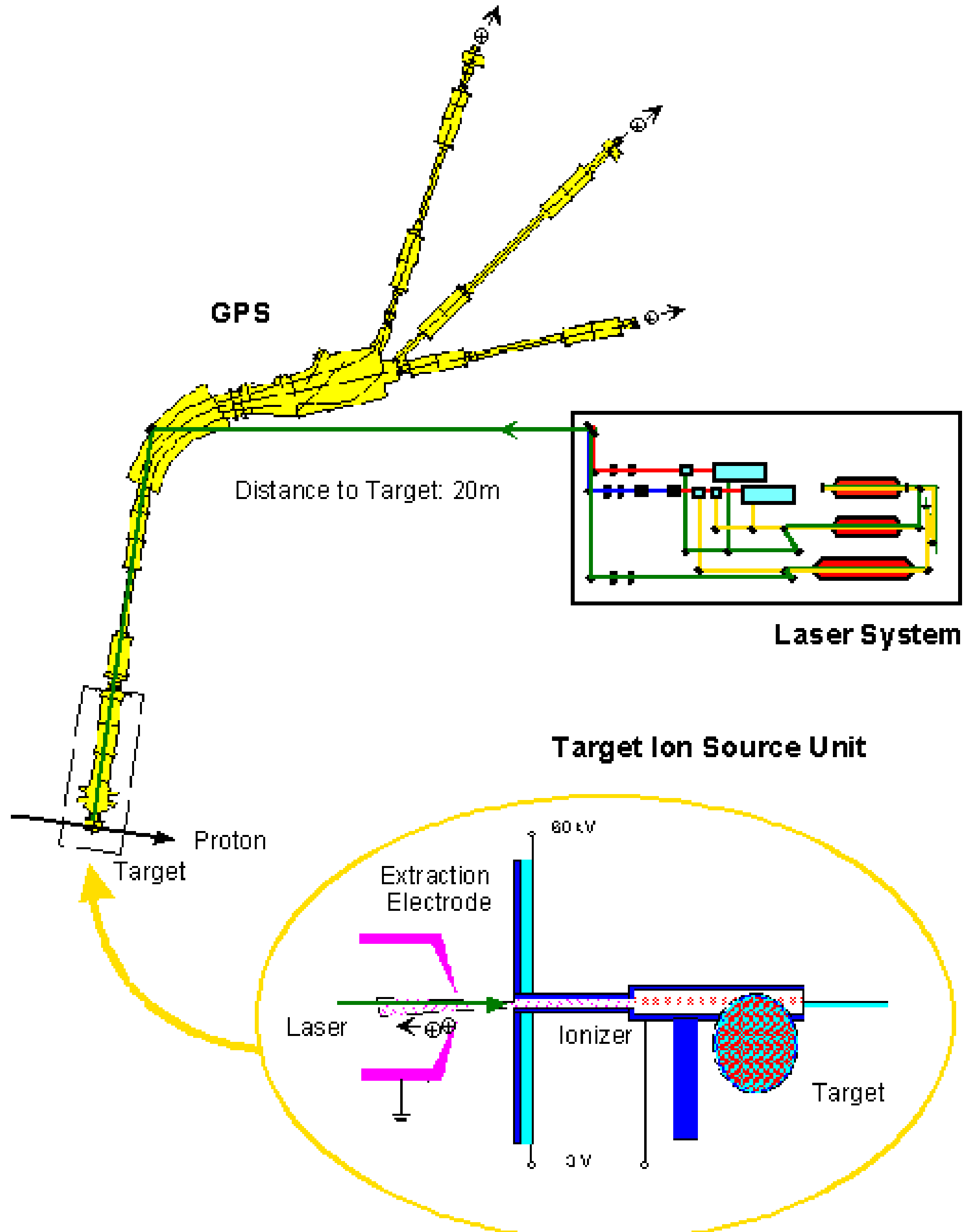
LISOL, Louvain-la-Neuve

TIARA (Takasaki)

Heavy Ion Research Facility (Lanzhou, China)

ISODE RILIS

- Copper vapor laser pumped dye lasers
- Hot cavity interface
- > 20 RIBS provided with overall efficiencies of the order of 10%



Areas in which improvements and developments can be made

- **Efficiency**
  - Higher laser power in the ionizer cavity
  - Improved ion extraction
  - Development of ionization schemes utilizing autoionizing states instead of ionizing directly to the continuum
  - Fractionated ground-state population
- **Selectivity**
  - Ionization via laser excitation competes with surface ionization in a hot cavity
  - Investigate schemes to ionize refractory elements that may be transported as molecules
- **Reliability and Maintenance**
  - Use solid state pump lasers instead of copper vapor lasers
  - Use Ti:sapphire lasers to replace dye lasers (a gap in wavelength of 500-700 nm will result)

Requirements for a new Laser Ion Source

- **High power**
- **High repetition rate (> 10 kHz)**
- **High reliability**
- **Easy tunability**
- **Reduction of consumables and maintenance**
- **Cover a wide range of wavelengths**
- **Capability for 2-step and 3-step ionization schemes**

Closing Comments

- **This research can be accomplished at the Holifield Radioactive Ion Beam Facility (HRIBF) in an operating ISOL environment with both stable isotopes and short-lived radioactive isotopes**
- **At ORNL, laser expertise exists in the atomic physics group and among some members of the group presently working in ion source development**
- **Useful discussions have been initiated with Ulli Koester (ISOLDE) concerning what directions/problems a new laser ion source development project should focus on**
- **The plan is not to develop new laser technology but to use state-of-the-art laser technology to improve the laser and ion source coupling, develop new ionization schemes, and develop a system that is reliable, efficient, easily tuned, and easy to maintain**